

AMENDMENTS TO THE CLAIMS

Please cancel Claims 1-12, 15 and 16 and amend Claims 13, 14, 17 and 18 as indicated below.

1. – 12. (Cancelled)

13. (Currently Amended) A method of fabricating trench isolation structures between integrated electrical devices in a semiconductor substrate, comprising:

placing a semiconductor substrate in a reaction chamber, the semiconductor substrate comprising trenches; and

completely filling the trenches with insulating material by atomic layer deposition to form a trench isolation structure, the atomic layer deposition process comprising a plurality of primary cycles, each primary cycle comprising, in sequence:

introducing a first vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a first reactant species conforming at least to surfaces of the trenches;

removing excess first vapor-phase reactant and byproduct from the reaction chamber;

introducing a second vapor-phase reactant to the substrate, thereby reacting with the first reactant species conforming at least to the surfaces of the trenches; and

removing excess second vapor-phase reactant and byproduct from the reaction chamber,

wherein filling the trenches further comprises a plurality of secondary cycles, each secondary cycle comprising, in sequence:

introducing a third vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a third reactant species conforming at least to surfaces of the trenches, the third reactant species being different from the first reactant species;

removing excess third vapor-phase reactant and byproduct from the reaction chamber;

introducing a fourth vapor-phase reactant to the substrate, thereby reacting with the third reactant species conforming at least to the surfaces of the trenches; and

removing excess fourth vapor-phase reactant and byproduct from the reaction chamber,

wherein the primary cycles deposit silicon oxide and the secondary cycles deposit aluminum oxide and ~~The method of Claim 12, wherein~~ filling the trench comprises depositing aluminum oxide to form the insulating material comprising silicon oxide and between about 26% and 34% aluminum oxide by weight.

14. (Currently Amended) A method of fabricating trench isolation structures between integrated electrical devices in a semiconductor substrate, comprising:

placing a semiconductor substrate in a reaction chamber, the semiconductor substrate comprising trenches; and

completely filling the trenches with insulating material by atomic layer deposition to form a trench isolation structure, the atomic layer deposition process comprising a plurality of primary cycles, each primary cycle comprising, in sequence:

introducing a first vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a first reactant species conforming at least to surfaces of the trenches;

removing excess first vapor-phase reactant and byproduct from the reaction chamber;

introducing a second vapor-phase reactant to the substrate, thereby reacting with the first reactant species conforming at least to the surfaces of the trenches; and

removing excess second vapor-phase reactant and byproduct from the reaction chamber,

wherein filling the trenches further comprises a plurality of secondary cycles, each secondary cycle comprising, in sequence:

introducing a third vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a third reactant species

conforming at least to surfaces of the trenches, the third reactant species being different from the first reactant species;

removing excess third vapor-phase reactant and byproduct from the reaction chamber;

introducing a fourth vapor-phase reactant to the substrate, thereby reacting with the third reactant species conforming at least to the surfaces of the trenches; and

removing excess fourth vapor-phase reactant and byproduct from the reaction chamber,

wherein the primary cycles deposit silicon oxide and the secondary cycles deposit aluminum oxide and ~~The method of Claim 12, wherein~~ filling the trench comprises depositing aluminum oxide to form the insulating material comprising silicon oxide and between about 23% and 37% aluminum oxide by weight.

15. – 16. (Cancelled)

17. (Currently Amended) A method of fabricating trench isolation structures between integrated electrical devices in a semiconductor substrate, comprising:

placing a semiconductor substrate in a reaction chamber, the semiconductor substrate comprising trenches; and

completely filling the trenches with insulating material by atomic layer deposition to form a trench isolation structure, the atomic layer deposition process comprising a plurality of primary cycles, each primary cycle comprising, in sequence:

introducing a first vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a first reactant species conforming at least to surfaces of the trenches;

removing excess first vapor-phase reactant and byproduct from the reaction chamber;

introducing a second vapor-phase reactant to the substrate, thereby reacting with the first reactant species conforming at least to the surfaces of the trenches; and

removing excess second vapor-phase reactant and byproduct from the reaction chamber

filling the trenches further comprises a plurality of secondary cycles, each secondary cycle comprising, in sequence:

introducing a third vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a third reactant species conforming at least to surfaces of the trenches, the third reactant species being different from the first reactant species;

removing excess third vapor-phase reactant and byproduct from the reaction chamber;

introducing a fourth vapor-phase reactant to the substrate, thereby reacting with the third reactant species conforming at least to the surfaces of the trenches;
and

removing excess fourth vapor-phase reactant and byproduct from the reaction chamber

wherein the primary cycles deposit a first oxide species and the secondary cycles deposit a second oxide species, at least a portion of the first and second oxide species combine to form a separate phase in equilibrium with a portion of the first oxide, and the separate phase comprises mullite, the first oxide comprises silicon oxide and the second oxide comprises aluminum oxide, The method of Claim 16, wherein the insulating material comprises between about 25% mullite and 50% mullite by weight.

18. (Currently Amended) A method of fabricating trench isolation structures between integrated electrical devices in a semiconductor substrate, comprising:

placing a semiconductor substrate in a reaction chamber, the semiconductor substrate comprising trenches; and

completely filling the trenches with insulating material by atomic layer deposition to form a trench isolation structure, the atomic layer deposition process comprising a plurality of primary cycles, each primary cycle comprising, in sequence:

introducing a first vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a first reactant species conforming at least to surfaces of the trenches;

removing excess first vapor-phase reactant and byproduct from the reaction chamber;

introducing a second vapor-phase reactant to the substrate, thereby reacting with the first reactant species conforming at least to the surfaces of the trenches; and

removing excess second vapor-phase reactant and byproduct from the reaction chamber

filling the trenches further comprises a plurality of secondary cycles, each secondary cycle comprising, in sequence:

introducing a third vapor-phase reactant to the substrate, thereby forming no more than about one monolayer of a third reactant species conforming at least to surfaces of the trenches, the third reactant species being different from the first reactant species;

removing excess third vapor-phase reactant and byproduct from the reaction chamber;

introducing a fourth vapor-phase reactant to the substrate, thereby reacting with the third reactant species conforming at least to the surfaces of the trenches; and

removing excess fourth vapor-phase reactant and byproduct from the reaction chamber

wherein the primary cycles deposit a first oxide species and the secondary cycles deposit a second oxide species, ~~The method of Claim 10,~~ wherein the primary and secondary cycles are mixed in a ratio to match a coefficient of thermal expansion (CTE) of the insulating material to within about 20% of a CTE of the semiconductor substrate.

19. (Previously presented) The method of Claim 18, wherein the primary and secondary cycles are mixed in a ratio to match a coefficient of thermal expansion (CTE) of the insulating material to within about 10% of a CTE of the semiconductor substrate.

20. - 58. (Cancelled)

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SUMMARY OF INTERVIEW

Applicants wish to thank the Examiner for the opportunity to discuss the present application in a personal interview conducted on May 5, 2004 at Examiner Mai's office.

Identification of Claims Discussed

Claims 1 and 6-19.

Identification of Prior Art Discussed

U.S. Patent No. 6,203,613 and Ritala et al.

Proposed Amendments

Rewriting Claims 13 and 17-18.

Principal Arguments and Other Matters

The principle arguments centered around the criticality of limitations in the above-identified claims.

Results of Interview

It was agreed that the Applicants should rewrite the discussed claims in independent form in a written response and argue criticality.